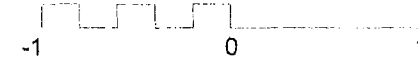MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 21.9 DB C/I MITIGATION ZONE
GREEN: 27.2 DB C/I MITIGATION ZONE
*

Site: N38-53-36; W77-04-07; EIRP:-17.5 dBW
Antenna Rad. Center: 134.4 m AMSL

KILOMETERS

-1   0   1
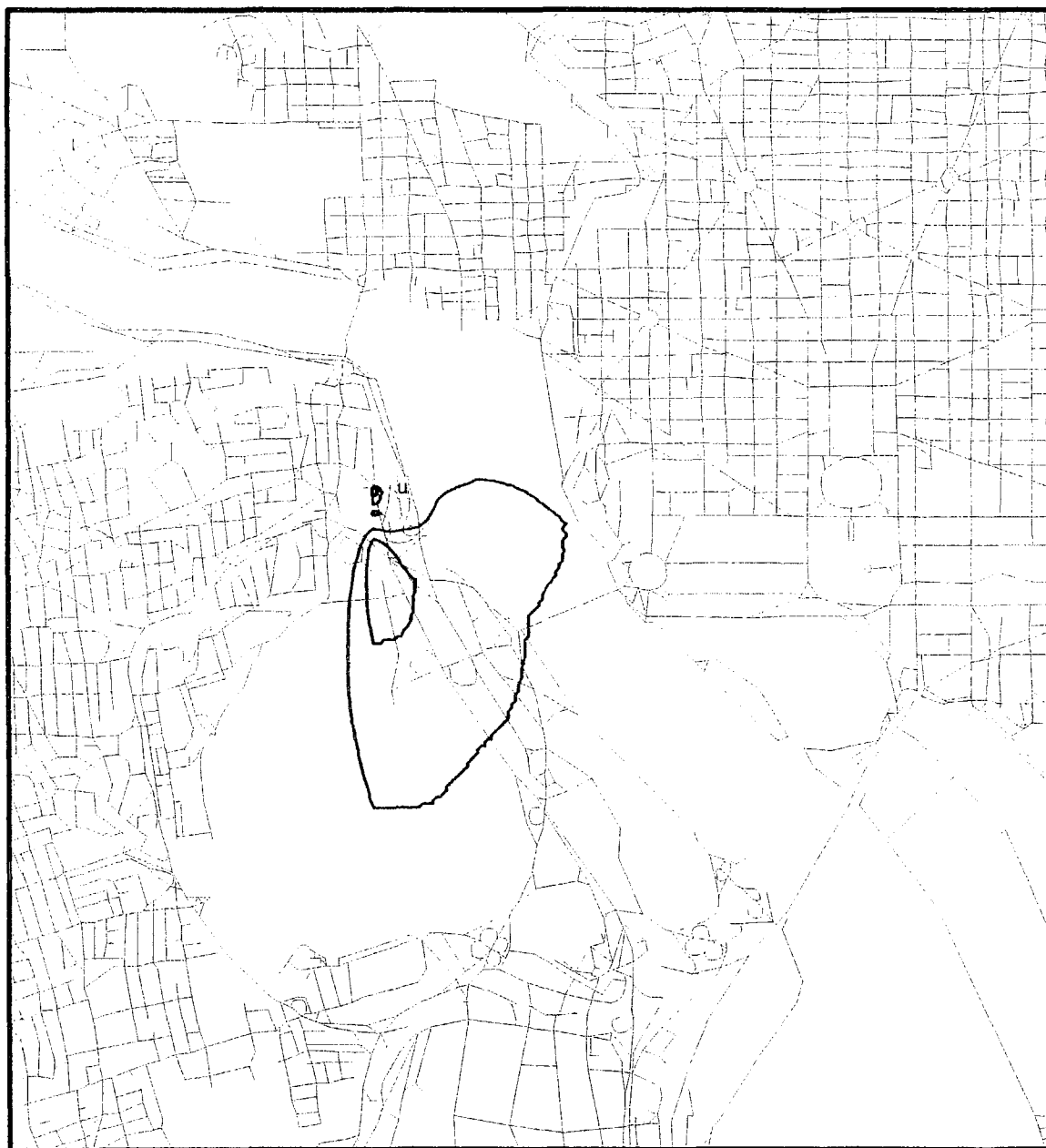
USA TODAY(Oriented at 113 deg)
SAT: 101

FIGURE 2B   02-08-00

MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 21.9 DB C/I MITIGATION ZONE
GREEN: 27.2 DB C/I MITIGATION ZONE
*

Site: N38-53-36; W77-04-07; EIRP:-17.5 dBW
Antenna Rad. Center: 134.4 m AMSL

KILOMETERS

-1   0   1

USA TODAY(Oriented at 113 deg)
SAT: 110

FIGURE 2C   02-08-00

MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 21.9 DB C/I MITIGATION ZONE
GREEN: 27.2 DB C/I MITIGATION ZONE
*
Site: N38-53-36; W77-04-07; EIRP:-17.5 dBW
Antenna Rad. Center: 134.4 m AMSL

KILOMETERS

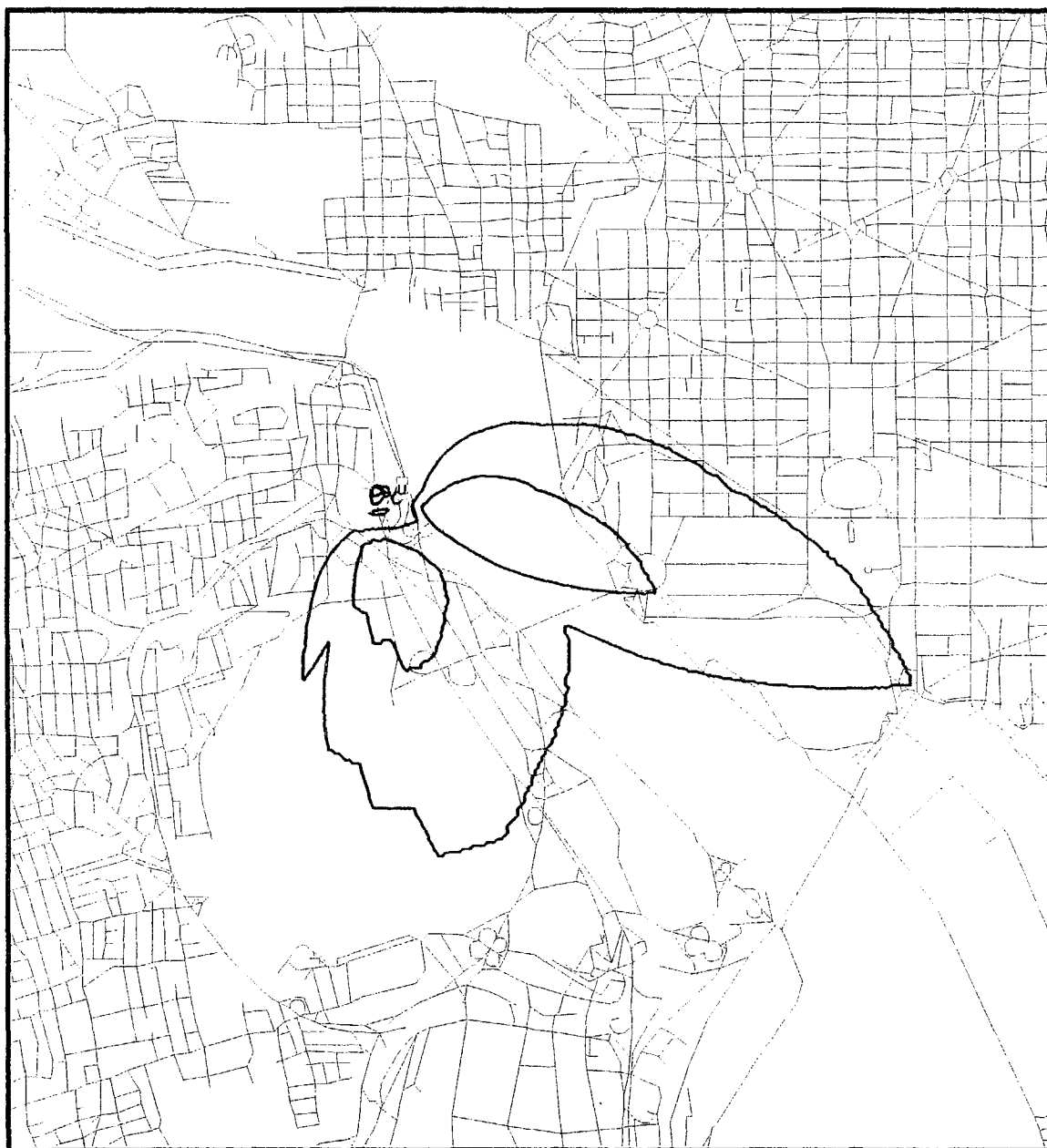-1   0   1

USA TODAY(Oriented at 113 deg)
SAT: 119

FIGURE 2D   02-08-00

MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
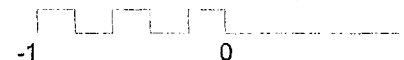BLUE: 21.9 DB C/I MITIGATION ZONE
GREEN: 27.2 DB C/I MITIGATION ZONE
*

Site: N38-53-36; W77-04-07; EIRP:-17.5 dBW
Antenna Rad. Center: 134.4 m AMSL

KILOMETERS

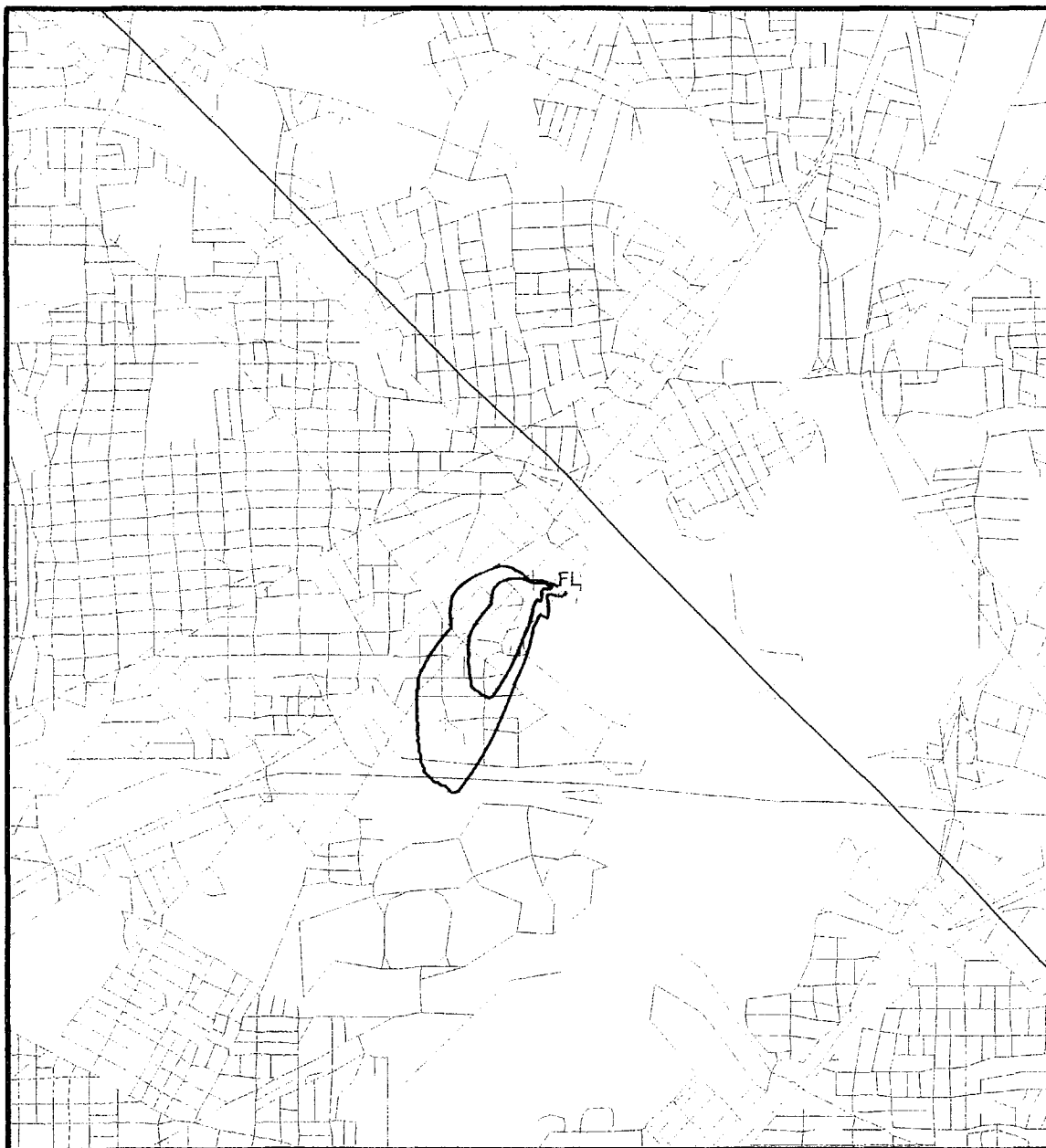-1   0   1

USA TODAY(Oriented at 113 deg)
SATs: 61.5,101,110 & 119
FIGURE 2E   02-08-00

MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 15 DB C/I MITIGATION ZONE
GREEN: 20 DB C/I MITIGATION ZONE
*

Site: N38-55-42; W76-57-39; EIRP:-17.5 dBW
Antenna Rad. Center: 69.8 m AMSL

KILOMETERS

-1   0   1

FT LINCOLN(Oriented at 225 deg)

SAT: 61.5

FIGURE 3A   02-08-00
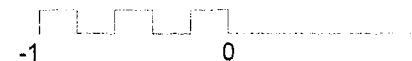
MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 15 DB C/I MITIGATION ZONE
GREEN: 20 DB C/I MITIGATION ZONE
*

Site: N38-55-42; W76-57-39; EIRP:-17.5 dBW
Antenna Rad. Center: 69.8 m AMSL

KILOMETERS

-1   0   1

FT LINCOLN(Oriented at 225 deg)

SAT: 101

FIGURE 3B   02-08-00
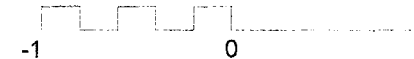
MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 15 DB C/I MITIGATION ZONE
GREEN: 20 DB C/I MITIGATION ZONE
*

Site: N38-55-42; W76-57-39; EIRP:-17.5 dBW
Antenna Rad. Center: 69.8 m AMSL

KILOMETERS

-1   0   1

FT LINCOLN(Oriented at 225 deg)
SAT: 110

FIGURE 3C   02-08-00

MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 15 DB C/I MITIGATION ZONE
GREEN: 20 DB C/I MITIGATION ZONE
*

Site: N38-55-42; W76-57-39; EIRP:-17.5 dBW
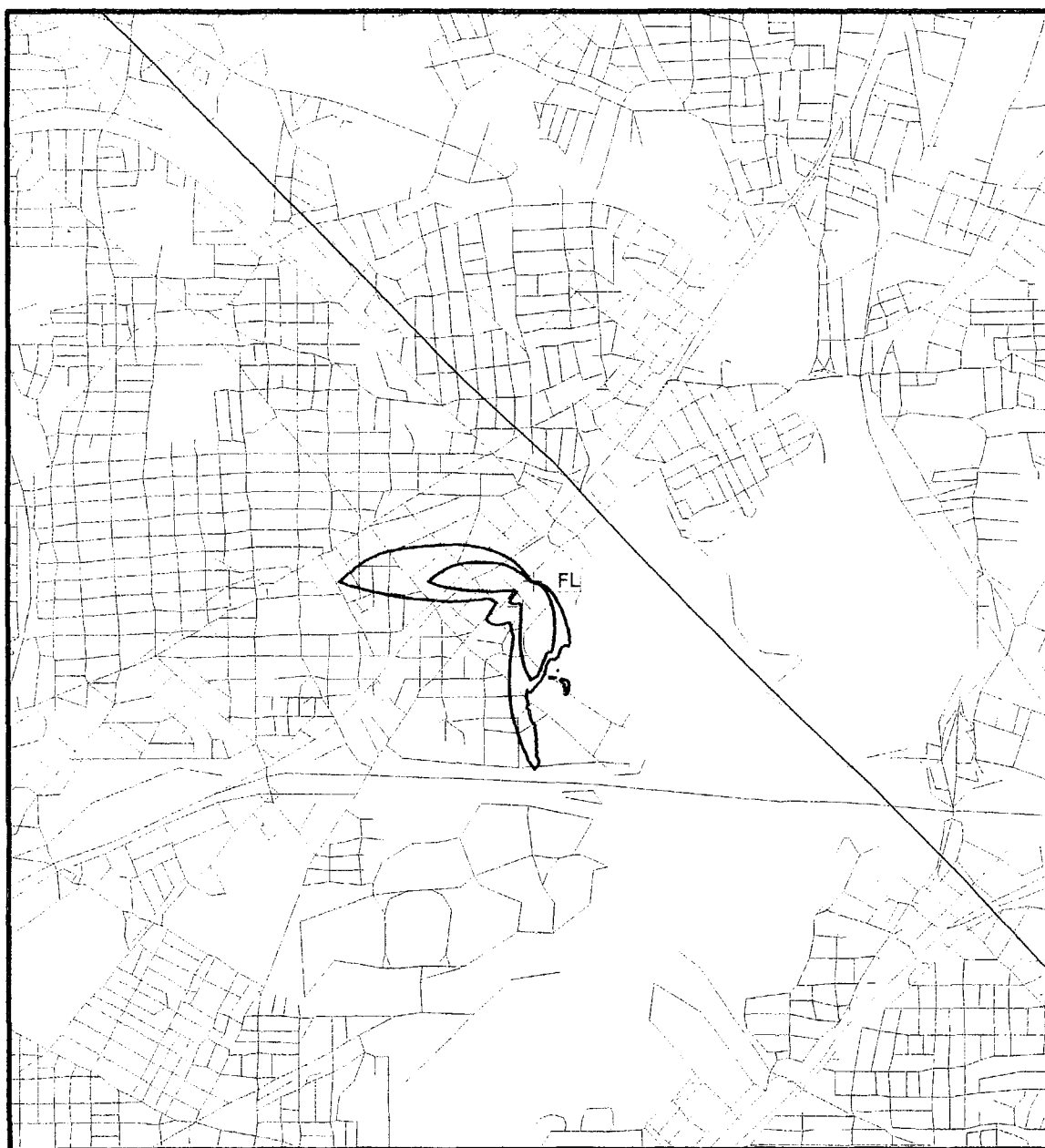Antenna Rad. Center: 69.8 m AMSL

KILOMETERS

-1   0   1

FT LINCOLN(Oriented at 225 deg)

SAT: 119

FIGURE 3D   02-08-00
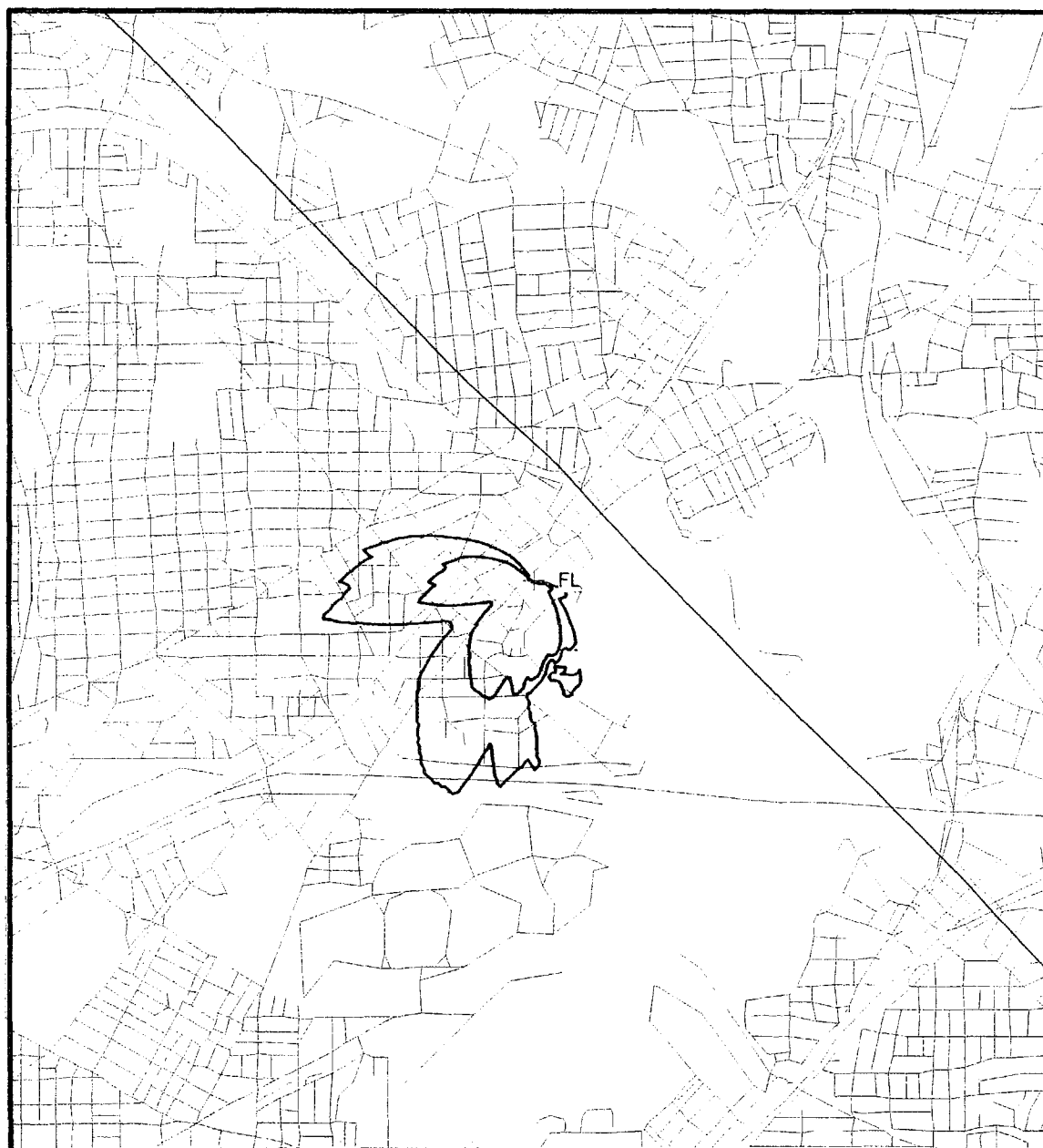
FL

MSITE™: washdc3.map

Prop. model: Free Space + RMD
Time: 50.0%   Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Groundcover: none
Atmospheric Abs.: none
K Factor: 1.333
RX Antenna - Type: DA
Height: 9.1 m AGL   Gain: 31.85 dBd

Notes

CONTOURS:
BLUE: 15 DB C/I MITIGATION ZONE
GREEN: 20 DB C/I MITIGATION ZONE
*

Site: N38-55-42; W76-57-39; EIRP:-17.5 dBW
Antenna Rad. Center: 69.8 m AMSL

KILOMETERS

-1   0   1

FT LINCOLN(Oriented at 225 deg)
SATs: 61.5,101,110 & 119

FIGURE 3E   02-08-00

EXHIBIT C

Methodology for Predicting

Terrestrial Interaction with DBS

In the 12.2 - 12.7 GHz Band

January 18, 2000

Bob Combs, Broadwave USA
Darryl DeLawder, DeLawder Communications

1.0 Summary

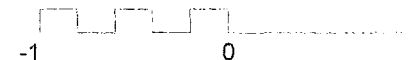This paper describes a methodology for predicting the impact of terrestrially based directional Northpoint-type, fixed, point-to-multipoint transmissions on co-channel reception of direct broadcast satellite ("DBS") services in a real world setting. This methodology predicts the potentially effected percentage of population by using an algorithm to calculate power levels for both services at given points, and then determining the area and population within a given Carrier to Interference ratio ("C/I ratio") contour. Market penetration and natural shielding can also be significant factors in determining the potential impact, and the methodology considers these factors as well. It is envisioned that this methodology will be used as Northpoint is deployed in order to minimize the impact of Northpoint operations on co-channel DBS reception.

Northpoint Technology

Northpoint is a terrestrial fixed point-to-multipoint system with a broadcast transmission typically oriented in a southerly manner. Northpoint operates at substantially lower power levels than most point-to-point fixed-service (FS) applications, and employs a number of localized engineering techniques to facilitate sharing frequency spectrum with satellite systems. One such technique is the transmit antenna directionality, which provides substantial isolation of 30 dB below vertical. By employing such localized interference mitigation techniques, the Northpoint system minimizes its RF energy at ground level near the transmitter, solving the "near-far" problem, and thereby facilitating sharing with the DBS customers within the Northpoint service area.

A methodology to define given C/I ratio contours is needed to identify both the potential mitigation zones located near a Northpoint FS transmitter site, and the potentially effected population within a given mitigation zone. Once these areas are defined, localized design solutions can be modeled to reduce the forecast impact to DBS users in areas where the methodology predicts C/I ratios that are lower than target values.

One such methodology is described in this paper. The geometry is identified in Section 2. The C/I ratio at any point is given in Section 3. In Section 4, a method for incorporating the population density and natural shielding factors is described. In Section 5, a commercial software program is used to evaluate a typical metropolitan layout, and to make an estimate of household counts within given C/I contours of the metropolitan FS system.

2.0 Sharing Geometry

The interference caused by terrestrial emissions into a DBS system is static, in contrast to the interference from non-geostationary satellites. As the interference power does not vary over time, once the geometry is specified, the interference environment can be completely identified. It is useful to define a coordinate system with origin at the ground level below the transmitter, and the Y-axis in the typical direction of transmission (south), as shown in Figure 1.

In Figure 1, the Northpoint transmission is due south, in the Y direction. (The methodology can easily be adapted for transmit antenna boresight angles other than due south.) A point R within the service area is at a given azimuth angle (α) relative to the boresight of the Northpoint transmit antenna. It is assumed that the earth station look angle, β (relative to true north), to the satellite is known.
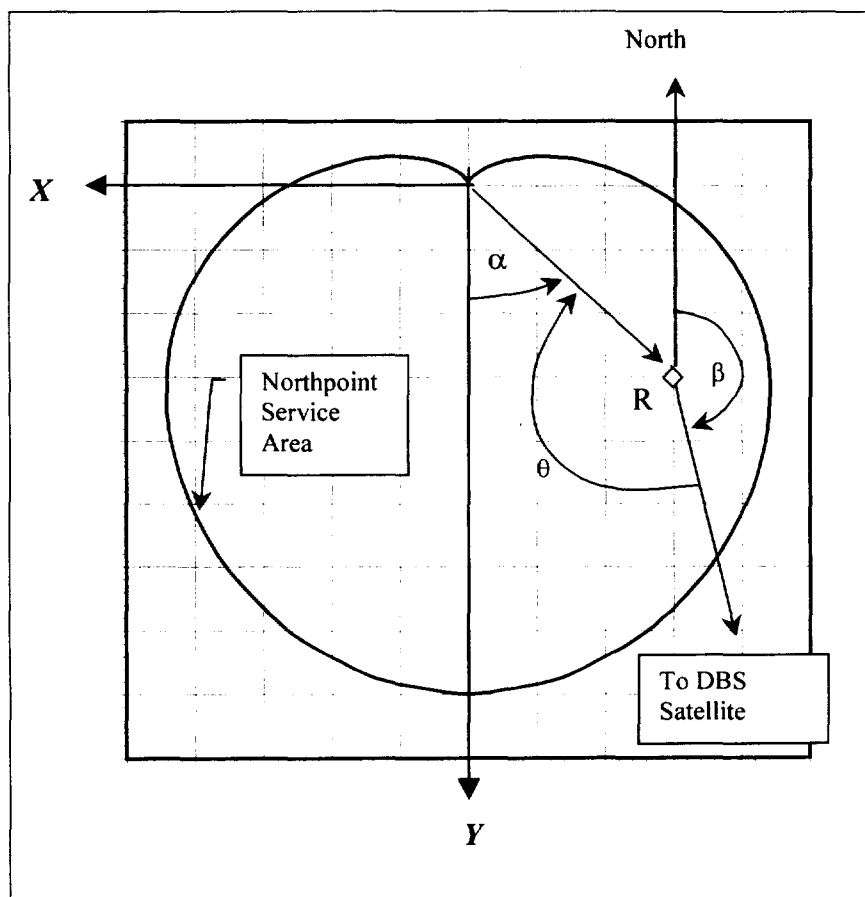
Figure 1. Coordinate System

Northpoint transmitters are typically installed on hills, towers or buildings. The geometry is presented in Figure 2. The transmitter is installed at a height above average terrain h_t. (The receiver can also have a height relative to average terrain (h_r), although the average height variation among DBS receivers will be equal to the average terrain, and therefore can generally be neglected.) The direction of maximum EIRP may also have a tilt angle t, relative to the

horizon plane (in order to minimize the power level near the transmitter). The relationship among the geometric variables follows Figure 2, and is presented in Table 1.
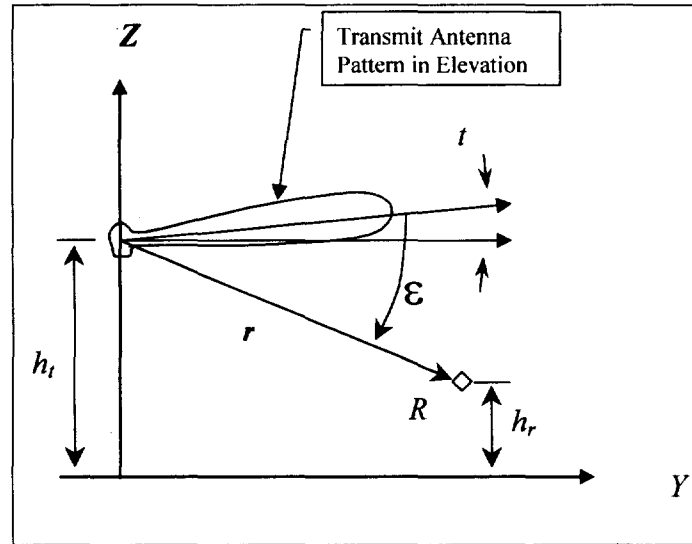
Figure 2. Elevation Geometry

Table 1. Geometry and Relationship among Geometric Variables

Symbol	Item	Calculation	Units
R	Point of interest (DBS receive antenna)	(x, y, h_r)	km
$r(x, y, h_t, h_r)$	Range to point R from transmitter	$= |(x, y, h_r - h_t)|$	km
h_t	Transmitter height above average terrain	Given	km
h_r	Receiver height above average terrain	Given	km
h	Transmitter height above receiver	$= h_t - h_r$	km
t	Transmitter tilt angle above the horizontal	Given	deg
$\alpha(x, y)$	Off boresight angle in azimuth from transmitter to victim	$= arctan(x / y)$	deg
$\varepsilon(h, x, y, t, \alpha)$	Off boresight angle in elevation from transmitter to victim	$= arctan((h / (x^2 + y^2)^{0.5})$ $+ t * cos(\alpha)$	deg
β	Receiver azimuth look angle to satellite	Given	deg
$\theta(\alpha, \beta)$	Off boresight angle to terrestrial transmitter	$= |\alpha + \beta|$	deg

In Table 1, the calculation of ε takes into account a possible tilt angle t of the fixed transmitter. Along the transmit antenna boresight, the antenna tilt angle is t. Opposite the boresight, the tilt angle is $-t$. In any given azimuth angle α, the antenna tilt angle is $t * cos(\alpha)$.

3.0 Carrier to Interference Ratio Calculation

C/I ratios of unfaded signals can be used to identify zones of potential interference (from the Northpoint FS system to DBS systems) where additional interference mitigation techniques may be required. The identification of appropriate interference criteria to be met by the C/I ratios is beyond the scope of this paper. The appropriate C/I ratio interference criteria would be based upon the level of interference deemed "harmful", and would vary with the DBS carrier power and the estimated local rain margin.

The interference power at the input of the DBS LNB is equal to the radiated power (in EIRP) in the direction of the victim receiver, minus any radio transmission losses, plus the gain of the DBS antenna in the direction of the Northpoint transmitter.

$$I = EIRP_{eff} - FSL(x) - (atmospheric\ losses) + G(\theta) + A \qquad dB \qquad Equation\ (1).$$

In equation 1, the first term, the $EIRP_{eff}$ is the effective terrestrial EIRP in the direction of the victim receiver, as calculated per Table 2. The only losses considered are due to free space and polarization isolation; atmospheric losses are negligible. The Northpoint transmit antenna is a broadbeam horn (as opposed to a parabolic reflector), and the antenna patterns between azimuth and elevation substantially differ. The typical antenna patterns are presented in the annex.

The DBS gain in the direction of the transmitter, $G(\theta)$, varies as a function of the relative azimuth towards the Northpoint transmitter. In North America, the most commonly used and most sensitive DBS antenna is the 45 cm offset feed parabolic reflector antenna. The gain towards the horizon of this typical receive antenna is well defined by the DBS antenna manufacturers. Because the antenna gain realized by this DBS antenna is significantly attenuated at angles below the nose of the antenna, the gain towards the horizon is typically more than 36 dB below maximum, and varies between -2 and -16 dBi. The average gain at the horizon is approximately -10 dBi. This gain is largely unchanged for satellite elevation angles between 20 and 50 degrees for the 45 cm offset feed parabolic reflector.[1] Thus, it is important to correctly determine the earth station antenna gain towards the fixed Northpoint transmitter, which is accomplished by using only the relative azimuth of the antenna bore sight and the fixed transmitter location. Only a methodology that uses the appropriate antenna gain will accurately describe the interference environment.

The interference power is calculated according to Table 2. The received undesired signal level I, from the Northpoint transmit facility (in the direction of R) is a function of the free space loss and the Northpoint transmit and DBS receive antenna patterns in elevation and azimuth (see annex). As mentioned above, atmospheric losses are negligible within a few kilometers of the transmitter, and can be ignored. (Attenuation, due to either buildings or foliage in the propagation path, can be significant, and will be taken into account at a later point.)

---

[1] Terrestrial Interference in the DBS Downlink Band, DIRECTV, 1994, and confirmed by recent and thorough studies, presented in ITU-R study groups, of the 45 cm offset feed most commonly used in North America.

Table 2. Interference Power Calculation

Symbol	Item	Calculation	Units
f	Frequency	*Given*	MHz
$TxAzDis(\alpha)$	Transmitter Azimuth Discrimination	*Function of the antenna pattern in azimuth and the angle α to point R, according to the pattern given in the appendix.*	dB
$TxElDis(\varepsilon)$	Transmitter Elevation Discrimination	*Function of the antenna pattern in elevation, and the angle ε to point R, according to the pattern given in the appendix.*	dB
$EIRP_{max}$	Maximum transmitted EIRP	*Given*	dBW
$EIRP_{eff}$	Transmitted EIRP in the direction of point R	$= EIRP_{max} - TxAzDis - TxElDis$	dBW
$FSL(x, f)$	Free space loss	$= 32.45 + 20\,log(x) + 20\,log(f)$	dB
A	Polarization Isolation Factor	$= -3$ *for linear to circular polarization*	dB
$G(\theta)$	Gain of the victim receiver in the direction of the terrestrial transmitter	*Per victim antenna pattern, see annex*	dBi
I	Interference Power	$= FSL + EIRP_{eff} + G(\theta) + A$	dB
C/I	Carrier to interference ratio	$= C - I$	dB

The C/I ratio into DBS can be calculated using the following equation:

$$C/I = C - EIRP_{eff} - FSL(x) + G(\theta) + A \qquad dB \qquad\qquad Equation\ (2).$$

In Equation 2, the first term C is the DBS carrier power at the input of the LNB, (see Table 3 for a sample calculation).

Table 3. DBS Carrier Power Calculation.

Symbol	Item	Calculation	Units
f	Frequency	*Given*	MHz
$EIRP_s$	Satellite EIRP in the direction of the receiver	*Given*	dBW
PL	Pointing loss of the receive antenna towards the satellite	*Given*	dB
Gas	Gaseous absorption attenuation of satellite carrier power	*According to ITU-R*	dB
$FSL(r, f)$	Free space loss	$= 32.45 + 20\,log(r) + 20\,log(f)$	dB
G	Receive Antenna Gain	*Given*	dBi
C	Satellite Clear Sky Carrier Level	$= EIRP_s - FSL(sat) - PL - Gas + G$	dBW

Tables 4 and 5 provide sample calculations for Washington D.C. (see Section 5).

Table 4. DBS Carrier Power Sample Calculation

Line	Symbol	Item	Input	Output	Units
1.	$EIRPs$	EIRP(sat)	51.7		dBW
2.	f	Frequency	12500		MHz
3.		Elevation Towards Satellite	38.6		°
4.		Range to Satellite	37889		km
5.	$FSL(sat)$	FSL (Satellite)		-206	dB
6.	Gas	Gaseous Absorption	-0.2		dB
7.	PL	Pointing Loss	-0.5		dB
8.	G	Antenna Gain	34		dBi
9.	C	Carrier Power Level (Clear Sky)		-121.0	dBW

Table 5. Sample Interference Calculation

Line	Symbol	Item	Input	Output	Units
1.		Site Latitude	38.9		°
2.		Site Longitude	77W		°
3.		Satellite Longitude	101 W		°
4.	$EIRP_{max}$	Transmitter maximum EIRP	-17.5		dBW
5.	A	Polarization isolation	-3.0		dB
6.	H	Tower height $(= h_t - h_r)$	0.075		km
7.	x	East delta component of point R	1.0		km
8.	y	South delta component of point R	2.0		km
9.		Range from tower base to point R		2.236	km
10.	r	Total path from transmitter to point R		2.241	km
11.	FSL	Pathloss from transmitter to victim		-121.3	dB
12.	α	Transmitter azimuth off bore sight angle		-26.6	°
13.	$TxAzDis$	Transmitter azimuth gain down from peak		-0.9	dB
14.	t	Beam Tilt	3.0		°
15.	ε	Transmitter OBS angle in elevation		-6.5	°
16.	$TxElDis$	Transmitter elevation gain down from peak		-1.3	dB
17.	$EIRP_{eff}$	Effective EIRP in direction of victim		-19.8	dBW
18.	β	Azimuth towards satellite	-144.0		°
19.	θ	OBS angle from victim to transmitter		117.4	
20.	$G(\theta)$	Victim gain towards transmitter		-4.5	dBi
21.	I	Total interference power		-148.6	dBW
22.	C/I	Carrier to interference ratio		27.0	dB

Determination of C/I Ratio Contours

A specific C/I ratio contour can be determined by setting Equation (2) equal to the desired C/I value and solving for the set of points that compose the contour. By integrating over the C/I ratio contour, the area inside any given contour is determined. The practical matter of generating C/I ratio contours and integrating the affected area may be accomplished in a spreadsheet by developing a grid of sufficient fidelity. In the following example, a 0.1 km delta grid of 18 x 18 kilometers (32,400 points) is used to determine the area inside a given contour.[2] Figure 3 provides the C/I ratio contours throughout the service area using the assumptions identified for Washington D.C. in the above sample calculations. Commercially available software, such as EDX MSite™, can also be used to generate C/I ratio contours, as discussed in Section 5.
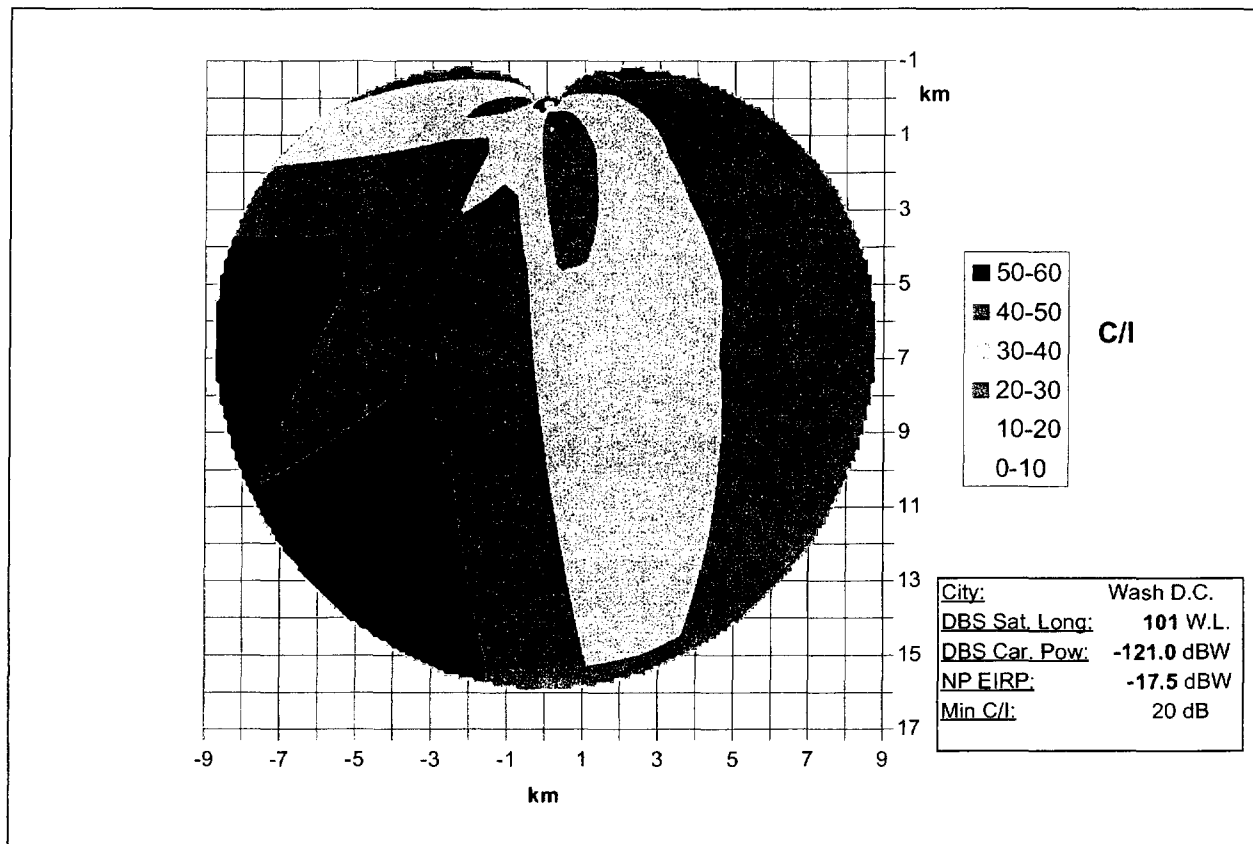
Figure 3. C/I Contours for Washington D.C.

The area inside a given C/I contour can be compared to the total service area for a particular FS transmit facility. In the case of Northpoint, the service area is defined by the area where the isotropic receive signal level is greater than about -156 dBW when only free space loss is taken into account. For an EIRP of -17.5 dBW, and using the azimuth antenna pattern in the appendix, the service area is 234 km^2.

---

[2] It was found that grid spacing of less than 0.1 km did not improve the accuracy of calculation.

A Microsoft Excel™ spreadsheet with Visual Basic was used to determine the C/I ratio at each point within the Northpoint service area in a 0.1 km delta grid of 18 square kilometers, for a total of 32,400 points. Use of the "count( )" and "countif( )" functions in the spreadsheet enables the user to determine the area of a specific C/I contour. The distribution of C/I values within the service area is shown in Figure 4. Note especially the small percentage of the service area where the C/I ratio is less than 30 dB, and that the average C/I ratio is greater than 40 dB.
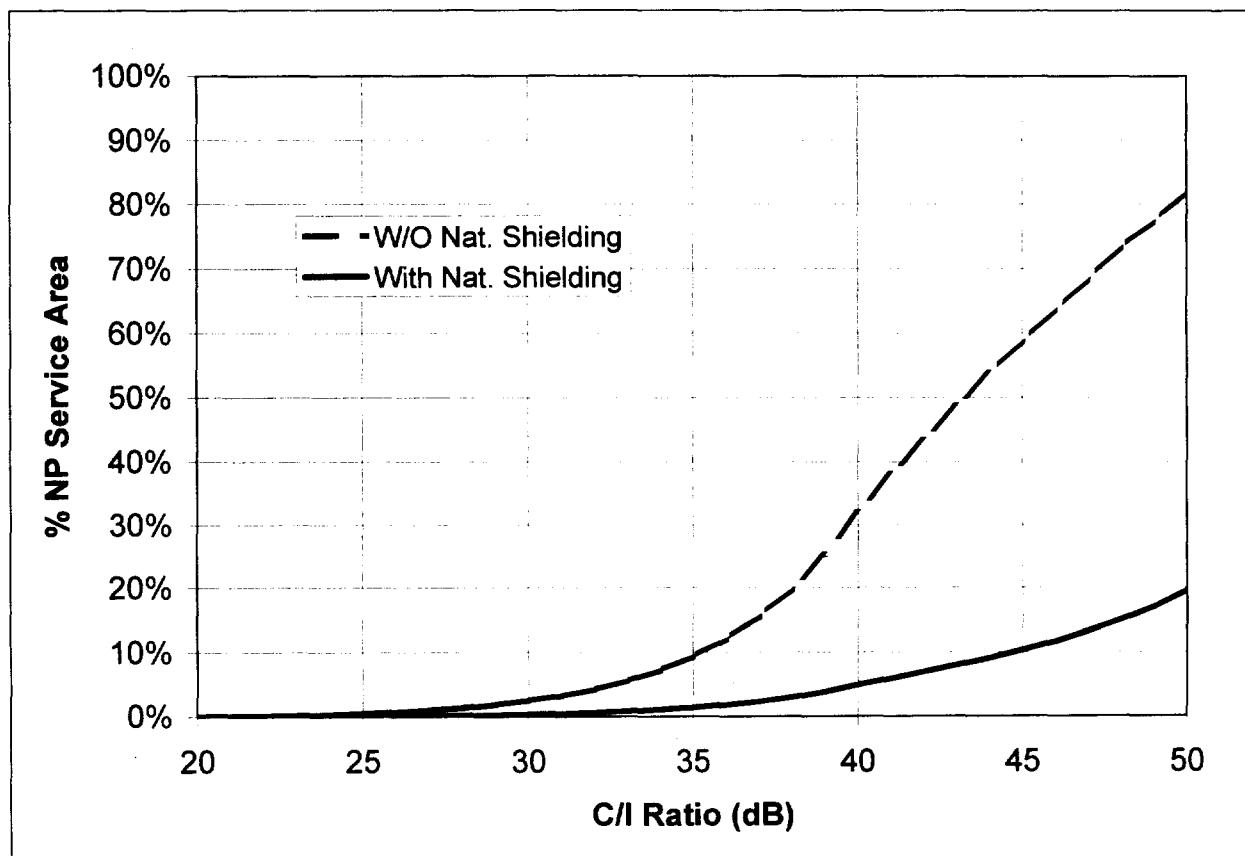
Figure 4. C/I Distribution Function for Washington D.C. Example

4.0 Determination of Potential Population in a Given C/I Ratio Contour

In the previous section, it was shown that the average C/I ratio in the Northpoint service area is over 40 dB. Furthermore, the area that might be deemed a mitigation zone will be very small -- on the order of 1% of the Northpoint service area. However, this does not mean that any DBS customer will be within the contour, or even if he is within the contour, that the Northpoint transmit facility will affect him. A number of factors significantly effect the interference environment. These factors include: market penetration, attenuation due to natural shielding, the location of transmitters in low population density areas, and localized engineering techniques that can be used to mitigate any potential interference. Taken together, these mitigation factors can reduce or eliminate any potential for interference. This section describes how these factors contribute to the sharing environment, and an example is presented of a possible implementation in a large metropolitan area.

Natural Shielding–Attenuation due to foliage and buildings along the propagation path will significantly reduce levels of interference. The amount of natural shielding present for DBS customers was recently identified in a national survey conducted by the survey firm of Bennett, Petis and Blumenthal in July of 1999. In this survey, it was found that 86% of DBS dish owners are naturally shielded due to a building, tree or other obstacle; therefore, only 14% of DBS customers will lack a natural shield.[3] The amount of protection that shielding can provide will vary greatly. It is a function of the type of material, as well as the amount of signal diffraction around the obstacle. An average of 15 dB of attenuation is assumed for the various obstacles identified in the survey, and this is sufficient in the mitigation of potential interference from a Northpoint transmit facility. The effect of natural shielding is also shown in Figure 4.

Market Penetration Rate–DBS market penetration currently averages 10% throughout the U.S.

Population Density–Northpoint tower locations can be selected to take advantage of variations in population density (PD). Typical transmitter locations are on high towers, high buildings and hills or mountains. Some, or many of these transmitter locations will be located in unpopulated areas, or areas lightly served by the DBS industry, such as industrial and commercial centers, regional public land, cemeteries, etc. In practice, the transmitters can be placed such that mitigation zones will exist in unpopulated or lightly populated areas. As a practical matter, each metropolitan area can be locally engineered to minimize transmitter installation in the densest urbanized areas. The population density can be determined using commercially available census data. In the example in the following section, it is shown that the household population density factor (HD) is on the order of 5%. That is, a metropolitan area can be designed for Northpoint service such that the household (or population) density near the transmitter is 1/20th that of the overall household (or population) density.

The effect of the various factors can be related through the following equation:

$$HH = A * NS * HD * MPR \quad \textit{Equation (3)}.$$

---

[3] Margin of error +/- 4% with 95% confidence level.

Equation 3 relates all the critical factors in determining a population within a given area. An estimate of the expected number of households within a given contour is provided in the following table.

Table 6. Estimate of the percent of households possibly affected by Northpoint

Item	Description	Order of Magnitude
A	Percent area of a given contour	On the order of 1%
NS	Percent of households not protected by natural shielding	On the order of 15%
HD	Relative household density in the mitigation zone	On the order of 5%
MPR	Market Penetration Rate	On the order of 20%
HH	Households estimated to require local shielding at the transmitter. (0.000015 = 0.01 * 0.15 * 0.05 * 0.2)	On the order of 0.0015%

As shown in the above table, it is estimated that less than 0.002% of DBS subscribers would actually be subject to potential interference from the Northpoint transmit facility, possibly requiring addition mitigation techniques such as local shielding.

Localized Engineering Techniques–A variety of interference mitigation techniques can be employed such as shielding at the transmitter, shielding at the receiver, lowering the transmit power, or transmitting slightly off azimuth 180 degrees (at azimuths typically from 135 to 225) to place mitigation zones in unpopulated areas.

As demonstrated in the following example, the combination of these techniques can eliminate any potential for interference in a metropolitan installation. In the Washington D.C. area, 24 Northpoint transmitters can serve a population of 1.3 million people.[4] Of this population, less than 10 households are estimated to be within a mitigation zone.

---

[4] 1990 Census Data

5.0 Greater Washington, D.C. Area Example

Figure 5, attached, is a map showing the predicted coverage for a Northpoint system design of the Greater Washington, D.C. area. In designing the system, two levels of service were considered:

- A receive power level of greater than -92 dBmW at the input to the LNB is used to represent a service reliability of 99.7 percent, which is considered the minimum acceptable reliability of a Northpoint system design;

- A higher level of service reliability (99.9 percent) is predicted to exist for receive power levels above -85 dBmW at the input to the LNB.

The predicted service and interference studies of this example use EDX Engineering, Inc.'s "Free space + RMD" Signal Propagation Model (which is one of many propagation models supported by the EDX software program MSITE™) in order to determine signal propagation from each Northpoint transmitter. The acronym "RMD" stands for "reflection plus multiple diffraction loss"; and this prediction model determines free space loss plus terrain obstruction signal attenuation in determining the signal strength at a receive location. Other potential attenuation structures such as foliage and man-made structures are not included in this model.

MSITE™ supports various other propagation models[5]; however, EDX's 'Free space + RMD' model is deemed the most appropriate choice. In the literature supporting MSITE™, EDX states that the 'Free space + RMD' model "is the most appropriate to use for microwave path design, or area-wide system studies operating at microwave frequencies (such as MMDS) where the receive sites are not random or mobile locations, but engineered receive sites with directional antennas." In fact, the FCC has recently authorized the use of this model in its implementation of two-way rules for the ITFS and MDS, and a complete description of the 'Free space + RMD' model is included in Appendix D to that Report and Order.[6]

Twenty-three sites with twenty-four transmitters are employed in the design, resulting in the predicted coverage (-92 dBmW or greater) of 1,303,245 households. Most transmitter sites are located at existing tower sites, with the Northpoint antenna located at or near the overall height specified for each structure.[7] (For the taller tower structures which are more than 300 feet AGL, a height approximately 50 feet below the overall height, is typically used as the antenna radiation center height.)

Figure 5, attached, is a map of the Washington system showing the location of the 24 transmitter sites in relation to the household distribution (as centroids[8]) of the Greater Washington service area.

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[5] Including the more familiar Longely-Rice (version 1.2.2) and the NTIA Terrain Integrated Rough Earth Model (TIREM).

[6] MM Docket No. 97-217, released September 25, 1998.

[7] All sites have been surveyed, the majority are existing towers in the FCC/FAA database, according to Dataworld (Dataworld.com).

[8] The MSITE™ program uses household "centroid" information taken from a 1990 U.S. Census database. A household centroid is a point location that defines a certain number of households located in the immediate area surrounding that point.

As explained in Sections 4 and 5, the potential interference to DBS transmissions will result to a small area located near the base of each tower. By applying a very conservative C/I ratio of 20 dB, and assuming that the Northpoint antenna is oriented generally southward, the DBS concern area will generally exist within 1.5 kilometers of a Northpoint transmitter site which transmits at a nominal EIRP level of -17.5 dBW. Because the Northpoint horn antenna will be typically oriented to the south, the interference area will generally be further restricted to areas south of each transmitter site.

Close examination of Figure 5 demonstrates that very few households are shown to be located in the potentially affected areas to the south of each transmitter site. Furthermore, the number of affected households can be reduced for a particular Northpoint transmit facility by making slight adjustments to the antenna orientation, EIRP or mechanical beam tilt used at the site. In order to minimize interference (and to otherwise maximize service) for any particular Northpoint site such adjustments have been made to the various sites of the Washington system. For various sites, these adjustments include the re-alignment of the transmit antenna by as much as 50° from due south; the increase or decrease of EIRP levels by as much as 3 dB; and the addition of up to 3° of upward mechanical beam tilt. The results of these adjustments are the final system design. Table 7 lists the location and transmit facilities for the 24 individual transmitters in this design.

Table 7. Transmitter locations in the Washington D.C. metro area example

Site	Location	Latitude	Longitude	EIRP (dBW)	Antenna Azimuth Orientation	Beam Tilt	Antenna Height (ft AGL)
WA00_330	USA Today (Arlington)	38,53,36	77,04,07	-19.7	113	0	328
WA03_729	Bethesda, MD	38,58,35	77,06,53	-19.7	170	0	649
WA05_250	Henderson Corner, MD	39,12,45	77,14,19	-18.1	140	0	250
WA07_455	Potomac, MD	39,02,07	77,10,11	-21.7	130	0	405
WA18_200	Brookville, MD	39,11,23	77,06,14	-17.7	150	0	199
WA20_404	Scaggsville, MD	39,08,29	76,54,33	-16.7	160	0	354
WA22_300	Olney, MD	39,08,00	77,02,47	-20.9	210	0	300
WA23_300	Hunting Hill, MD	39,05,00	77,13,25	-17.7	200	0	300
WA28_300	Sterling, VA	39,01,46	77,24,41	-17.7	130	0	300
WA31_300	Colvin Run, VA	38,59,32	77,20,53	-18.2	160	0	300
WA33_317	Fairfax, VA	38,51,17	77,22,28	-19.9	180	0	317
WA36_689	Merrifield, VA	38,52,28	77,13,24	-19.7	150	0	639
WA38_753	Silver Spring, MD	38,59,59	77,03,27	-19.7	130	0	703
WA11_210	Greenbelt, MD	38,59,56	76,51,15	-22.7	220	0	210
WA12_500	Davidsonville, MD	38,52,33	76,41,23	-16.7	210	0	350
WA15_152	Oxon Hill, MD	38,48,19	76,58,48	-21.7	130	0	152
WA42_278	NE Washington, DC	38,55,08	76,59,47	-20.9	130	1	278
WA43_155	Reagan N'tnl: Antenna 1	38,50,48	77,01,54	-17.2	230	0	155
WA43_155	Reagan N'tnl: Antenna 2	38,50,48	77,01,54	-16.7	130	0	155
WA48_490	Alexandria, VA	38,45,13	77,07,37	-20.2	130	0	430
WA49_300	Woodbridge, VA	38,44,20	77,17,20	-18.7	180	0	300
WA52_495	Patuxent, MD	39,01,48	76,44,24	-17.7	180	0	445
WA54_200	Bladensburg, MD	38,55,35	76,50,51	-18.7	180	0	200
WA59_400	Accokeek, MD	38,41,16	76,59,47	-20.9	150	2	390

Using the facilities listed in Table 7, the 15 and 20 dB C/I contours have been determined for each Northpoint transmitter site, as these contours are predicted to exist to each satellite service located at 61.5°, 101°, 110° and 119°, as plotted in Figure 5. The map includes the 15 dB (in blue) and 20 dB (in green) C/I ratio contours for each site as well as the household centroids.

Table 8, attached, includes household interference data for the 61.5°, 101°, 110°, 119° and composite DBS locations, as is predicted to exist from the example Northpoint system for Washington. Specifically, the number of households located within the 15 and 20 dB C/I contours for each Northpoint transmitter site, as determined by MSITE™, are reported in these figures. The MSITE™ program considers all households of a centroid as receiving DBS interference at a given contour level if the centroid is located within the contour. Likewise, if the centroid is located outside the contour, none of the households within a centroid are predicted to receive interference at that contour level.

Table 8
WASHINGTON D.C. HOUSEHOLD (HH) INFORMATION (Using 1990 Census Data)

SITE	Northpoint Houseolds Served Northpoint Reliability 99.7%	99.9%	SAT 61.5 Households Within 20 dB C/I	15 dB C/I	SAT 101 Households Within 20 dB C/I	15 dB C/I	SAT 110 Households Within 20 dB C/I	15 dB C/I	SAT 119 Households Within 20 dB C/I	15 dB C/I	SAT COMBINED* HH within 20 dB C/I	HH within 15 dB C/I
WA00_330	307,865	74,962	0	0	0	0	0	0	0	0	0	0
WA03_729	274,989	39,515	0	0	0	0	0	0	0	0	0	0
WA05_250	80,225	26,560	0	0	0	0	0	0	0	0	0	0
WA07_455	77,913	11,277	0	0	10	0	0	0	0	0	10	0
WA18_200	54,744	8,887	0	0	0	0	9	0	9	9	9	9
WA20_404	104,057	28,561	16	16	14	0	14	0	14	0	30	16
WA22_300	79,744	14,947	0	0	0	0	0	0	0	0	0	0
WA23_300	47,038	6,430	0	0	0	0	0	0	0	0	0	0
WA28_300	50,748	19,833	0	0	35	0	35	0	35	0	35	0
WA31_300	80,750	26,560	0	0	0	0	0	0	0	0	0	0
WA33_317	36,322	3,340	0	0	0	0	53	0	53	0	53	0
WA36_689	155,436	29,440	0	0	0	0	0	0	0	0	0	0
WA38_753	306,579	54,751	0	0	0	0	0	0	0	0	0	0
WA43_155	218,497	119,005	0	0	0	0	8	0	0	0	8	0
WA49_300	37,765	10,168	0	0	0	0	0	0	0	0	0	0
WA11_210	58,963	13,716	0	0	0	0	0	0	0	0	0	0
WA12_500	24,022	3,457	0	0	7	0	0	0	0	0	7	0
WA15_152	31,242	10,668	4	0	107	0	107	0	107	0	111	0
WA42_278	166,714	52,730	35	0	0	0	0	0	0	0	35	0
WA48_490	37,660	19,975	0	0	0	0	0	0	0	0	0	0
WA52_495	41,988	12,588	0	0	0	0	0	0	0	0	0	0
WA54_200	85,180	20,163	0	0	0	0	0	0	0	0	0	0
WA59_400	16,268	1,321	5	0	0	0	0	0	0	0	5	0
Total	1,303,245	563,221	60	16	173	0	226	0	218	9	303	25
Total as % of population											0.023%	0.002%

*There is some overlap of the various contours, so that the total households for individual satellites does not equal the sum of the individual contours.